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AGE AND CORRELATION OF THE "NEW RED" OR NEWARK GROUP IN PENNSYLVANIA.

BY EDGAR T. WHERRY, PH.D.[1]

The so-called "New Red" or Newark group of rocks of the Eastern United States has heretofore been almost universally regarded as a geologic and paleontologic unit, and correlated with the Rhætic or uppermost Triassic of Europe. Mr. Benj. Smith Lyman, Director of the Mineralogical and Geological Section, who was the first to make a detailed study of any portion of these beds, found them in eastern Pennsylvania to be unexpectedly thick (27,000 feet) and capable of considerable subdivision, and accordingly put forward the suggestion that the group is not all of the same age, but that its deposition began in some portion of the late Paleozoic and continued throughout the Triassic and perhaps even into the Jurassic.[2] This view was considered briefly by Ward[3] and cast aside, but the question has never been really settled, and is here reopened and discussed in detail.

The Paleozoic age of the lowermost beds was inferred by Mr. Lyman from the supposed occurrence of:

Lepidodendron of Lower Carboniferous type at Newark, N. J.
Calamites of Permian age at Holicong, Bucks County, Pa.
Dendrophycus of Devonian aspect at Portland, Conn.

To which may be added, silicified wood related to Permian species of Europe as described by Knowlton[4] and by the writer.[5]

The identification of the *Lepidodendron* was made by Lesquereux on a photograph of a poorly preserved fragment, and must therefore at best be regarded as doubtful, even had no other examination of the material ever been made. But Newberry[6] and Fontaine,[7] studying the same or a similar specimen, agreed that it represents a conifer, probably *Abies* or *Palissya*, while Berry thinks that "all that can be safely said is that it is the decorticated trunk of a gymnosperm."[8] As a matter of fact, the building-stone beds, from which it was obtained, are stratigraphically many thousand feet above the base of the Triassic.

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[1] The subject-matter of this paper has been presented in the form of occasional notes at meetings of the Mineralogical and Geological Section of the Academy.

[2] Age of the Newark Brownstone, *Proc. Amer. Phil. Soc.*, XXXIII, pp. 5–10; and Some New Red Horizons, *ib.*, pp. 192–215, 1894.

[3] Status of the Mesozoic Floras of the U. S., *Ann. Rept. U. S. Geol. Surv.*, XX, pt. ii, pp. 218–221, 1900.

[4] Fossil Wood and Lignite of the Potomac [and Newark] Formation, *Bull. U. S. Geol. Surv.*, No. 56, p. 52, 1889.

[5] Preceding paper.

[6] Fossil Fishes and Fossil Plants of the Triassic Rocks of New Jersey and the Connecticut Valley, *Mon. U. S. Geol. Surv.*, XIV, pp. 94, 95, 1888.

[7] In Ward's Status of the Mesozoic Floras of the U. S., *Ann. Rept. U. S. Geol. Surv.*, XX, pt. ii, p. 219, 1900.

The *Calamites* from Bucks County, discovered many years ago by Mr. John S. Ash, had been identified by Lesquereux as *Calamites arenaceus*, a Triassic species,[9] and later by Dr. N. L. Britton[10] as *Schizoneura laticostata* (or *planicostata*), a form occurring in the Upper Triassic of Virginia. As there still seemed to be a possibility, however, that the fossil was of Permian age, the writer in 1908 carried on excavations at the locality, and sent the material then obtained together with specimens of this plant and a cycad previously collected by Mr. Ash and by the Mineralogical and Geological Section of the Academy to the United States National Museum for identification. It was there examined by Messrs. David White and F. H. Knowlton, the foremost authorities on Carboniferous and Triassic plants, respectively, and they reported as follows:

"The equisetalean stem fragments probably belong to *Schizoneura*, with which they accord fairly well. The gymnospermous fragment seems to belong to *Cycadites*, and has many characters in common with *C. tenuinervis* of the southern Newark. The material affords no evidence of Paleozoic age, the equisetalean specimens being generally unlike the Paleozoic *Calamites* and *Equisetites*, while the genus *Cycadites* is unknown in the cosmopolitan Permian flora.[11] Though of relatively little value, the data embraced in this collection points toward Triassic age."

The "dendrophycus" is of no diagnostic value because it is of inorganic origin, representing a rill-mark,[12] and of course water flowed over mud about the same in the Triassic as in the Carboniferous period. So there remains to be considered only the silicified wood. Of the three species found in Pennsylvania one has its nearest relative in the Permian of Europe, although the other two are more like Jurassic forms, as pointed out in the preceding paper. The apparent similarities would no doubt largely disappear, however, if well-preserved material were available for direct comparison, for published descriptions and figures necessarily leave much to be desired as far as really complete characterization is concerned. Furthermore, it is generally recognized that because of the relative stability of internal structures as compared with external characters, identification for purposes of correlation must be based on the latter; indeed, plants may pass from one formation or even period to another with the former apparently unchanged, and of all types of structure that of the araucarias is the most persistent, extending from the Devonian down to the present time.

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[8] A Brief Sketch of Fossil Plants, *Ann. Rept. State Geol. N. J.*, 1905, p. 124, note 2, No. 5.

[9] Lewis, H. C. A Great Trap Dyke Across Southeastern Pennsylvania, *Proc. Amer. Philos. Soc.*, XXII, p. 453, 1883.

[10] [Exhibition of Specimens.] *Trans. N. Y. Acad. Sci.*, V, p. 17, 1885.

[11] Although Göppert described two species from the Carboniferous limestone of Silesia: Beiträge zur Kenntniss Fossiler Cycadeen, *Neues Jahrb. Min. Geol. Paleont.*, 1866, pp. 131, 132, pl. II. [E. T. W.]

[12] Lull, R. S.: The Life of the Connecticut Trias, *Amer. Jour. Sci.*, [4], XXXIII, p. 403, 1912.

It appears, therefore, that there is actually not the slightest foundation for the idea that the deposition of the Newark group began during the Permian or any other portion of the Paleozoic. But it is not by any means certain that more than one limited subdivision of the European Triassic may not be represented within its bounds.

For purposes of comparison, a table of the subdivisions which have been recognized both here and in Europe is added.

TABLE I. SUBDIVISIONS OF THE TRIASSIC.

Pennsylvania.[13]	New Jersey.[14]		Great Britain.[15]	Germany.[15]
Pottstown Perkasie Lansdale (Brunswick) 16,000 feet.	Brunswick, 12,000 feet.		Rhætic, 250 feet.	Rhætic, 500 feet.
			Upper Keuper, 3,000 feet.	Keuper, 1,000 feet.
			Lower Keuper, 450 feet.	Lettenkohle, 230 feet.
Gwynedd, 3,500 feet.	Lockatong, 3,600 feet.			
				Muschelkalk, 1,000 feet.
Norristown, 5,500 feet.	Stockton, 4,700 feet.		Variegated sandstone, 2,000 feet.	
				Bunter, 1,500 feet.

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[13] Lyman, op. cit., p. 197, and Report on the New Red of Bucks and Montgomery Counties, *Summary Final Report, Penna. 2d Geol. Surv.*, III, pt. ii, pp. 2589–2638, 1895. Thicknesses somewhat modified in accordance with later work.

[14] Kümmel, H. B. The Newark System—Report of Progress, *Ann. Rept. State Geol. N. J.*, 1896, pp. 34–55; thicknesses, p. 59.

[15] Von Huene, F. Eine Zusammenstellung über die Englische Trias, etc., *Centr. Min. Geol. Paleont.*, 1908, p. 16; thicknesses from various sources.

A few words should be added concerning the nomenclature of the American formations. The upper portion of the Newark was divided by Mr. Lyman, as shown in the table, into three members: the Lansdale, a soft red shale, followed by the Perkasie, described as harder and darker in color, and the Pottstown, again soft and red. The writer has not been able to recognize the validity of this subdivision, as the Perkasie at its type locality, as well as at several other places, contains various secondary minerals, such as quartz, epidote, and stilbite and other zeolites, which are seen in microscopic sections to fill the spaces between the grains, and are also often crystallized out in crevices, showing it to be merely a metamorphosed phase of the otherwise soft red sediments. It is therefore most convenient to treat these three formations as a unit, for which the name Brunswick, first applied to the New Jersey area, may well be adopted. For the two lower formations the Pennsylvania names have priority, but since the New Jersey ones have been rather widely used it seems necessary to give both to insure against any misunderstanding.

While the earlier observers were inclined to consider the fossils of the American Newark as equivalent to forms from the Rhætic of Europe—the transition stage between the Triassic and Jurassic periods—the plants were shown by Stur[16] to match most closely those of the German Lettenkohle or lower Keuper, and more recently Dr. C. R. Eastman[17] has found the fish fauna to have its analogue in that of the upper Muschelkalk and the lower Keuper of the Alpine Province. In all of these discussions it has been taken for granted that the Newark is a geologic and paleontologic unit; and it must be admitted that little definite evidence to the contrary has as yet been obtained; but it seems incredible that the enormous thicknesses of beds developed here could all be represented by two or three hundred feet of the foreign Triassic. Mr. Lyman's plea for the more definite placing of fossil occurrences in the stratigraphic column is therefore worthy of more attention than it has received, for it is only by so doing that we can ever hope to learn the true relations and equivalences of the beds.

A geographical table of the more important fossil localities of Pennsylvania, exclusive of those of silicified wood, which were given in the preceding paper, is here introduced. The locality numbers correspond to those on the accompanying map.

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[16] Die Lunzer-Lettenkohlen Flora in den "Older Mesozoic Beds of the Coal Field of Eastern Virginia," *Verh. KK. Geol. Reichsanst.*, 1888, pp. 203–217.

[17] Triassic Fishes of Connecticut, *Bull. Conn. Geol. Nat. Hist. Surv.*, No. 18, pp. 23–25, 1911.

B. *Bucks County.*

1. Wycombe: Quarries ½ mile south and 1 mile southwest of station. Upper part of the Gwynedd-Lockatong formation.
   Estheria ovata Lea.
   Other crustacea and fish scales.
2. Holicong: Mr. John S. Ash's farm, ¼ mile northwest of the crossroads. For references see above. At least 3000 feet below the top of the Norristown-Stockton formation.
   Schizoneura sp.
   Cycadites sp. (cf. *tenuinervis* Fontaine).
3. Carversville: Road metal quarry ¼ mile to the east. A. P. Brown: New Cycads and Conifers from the Trias of Pennsylvania. *Proc. Acad. Nat. Sci. Phila.*, 1911, pp. 17–21, pl. I–V. Transition beds between the Norristown-Stockton and the Gwynedd-Lockatong formations.
   Podozamites formosus Brown.
   Zamites velderi Brown.
   Palissya diffusa (Emmons) Fontaine.
   " *obtusa* Brown.
   Cheirolepis munsteri Schenk.
   " *latus* Brown.

M. *Montgomery County.*

1. Gwynedd Tunnel, P. & R. Ry., north of Gwynedd Valley station. Cope: Synopsis of the Extinct Batrachia, Reptilia, and Aves of North America. *Trans. Amer. Phil. Soc.*, XIV, pp. 170–175, 1871. Also other references by Leidy and Lea in *Proc. Acad. Nat. Sci. Phila.*, 1859, etc. Middle of the Gwynedd-Lockatong formation, of which it is the type locality.
   Numerous bones of a pterosaur, *Rhabdopelix longispinis* Cope.
   Various fish scales and reptile teeth.
2. Arcola: Perkiomen R. R. cuts ¼ mile and ¾ mile southeast of station. Bottom of Gwynedd-Lockatong.
   Estheria ovata Lea.
   Fish scales.
3. Yerkes: Perkiomen R. R. cut near station. Leidy: Fish Remains of the Mesozoic Red Shales. *Proc. Acad. Nat. Sci. Phila.*, 1876, p. 81. Base of Brunswick.
   A few fish scales, *Radiolepis elegans* Emmons?.
4. Graters Ford: Fishers quarry, 1 mile northwest of station. Lower part of Brunswick. Fossil footprints, of several species.

C. *Chester County.*

1. Phœnixville: P. & R. Ry. tunnel ½ mile north of station. Has been the subject of numerous papers, the most elaborate of

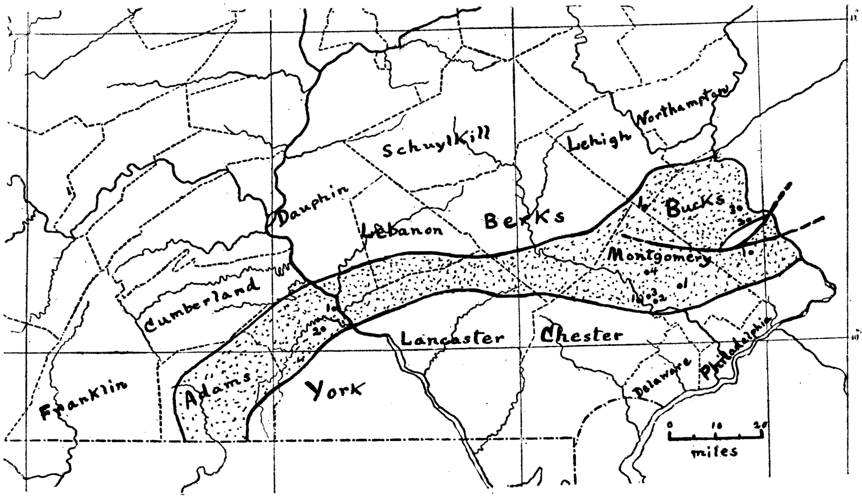
which is that of Wheatley: Remarks on the Mesozoic Red Sandstone of the Atlantic Slope, and Notice of the Discovery of a Bone Bed Therein. *Amer. Jour. Sci.*, [2], XXXII, pp. 41–48, 1861. Middle of Gwynedd-Lockatong formation.
Plants, species of *Equisetum, Pterozamites*, and *Ctenophyllum*.
Estheria ovata and other crustacea.
Fish scales.
Reptile teeth and bones.

L. *Lehigh County.*

1. Hosensack: Road cut somewhere southwest of the village. Lea: Description of a Fossil Saurian of the New Red Sandstone Formation of Pennsylvania; with some Account of that Formation. *Jour. Acad. Nat. Sci. Phila.*, [2], II, pp. 185–202, Pl. XVII–XVIV, 1854. Middle of the Brunswick.
Reptilian bones: *Clepysaurus pennsylvanicus* Lea.

Y. *York County.*

1. York Haven and vicinity. Wanner and Fontaine, in Ward's Status of the Mesozoic Floras of the U. S., *loc. cit.*, pp. 233–255, 1900. Middle of the Gwynedd-Lockatong.
Numerous fossil plants.
2. Emigsville: Copper prospects 2 miles northwest. Frazer and Cope: [Fossils from York County], *Proc. Amer. Phil. Soc.*, XXIII, pp. 403, 404, 1886.
Reptile bones and teeth.



Nearly all of these localities, as pointed out by Mr. Lyman, are in the Gwynedd-Lockatong formation. As this consists of a series of carbonaceous and calcareous rocks, no doubt representing a time of swamp development, attributable to a temporary modification of climatic conditions, which would of course affect the whole region at the same time, the fossils from the various places could hardly be expected to be otherwise than equivalent. It is these that are used in correlation of the "Newark" with the European Keuper. The only fossil locality at any considerably lower horizon is that at Holicong, Bucks County (B. 2). The forms occurring there are unfortunately not specifically identifiable, and so can throw little light on the age of the beds. But since both *Cycadites* and *Schizoneura* are genera which are found in the Bunter or lower Triassic of Europe, it is by no means impossible that the Norristown-Stockton formation is really the approximate equivalent of that horizon, which it certainly closely resembles lithologically.

Because of the total absence of fossils of diagnostic value in the upper 10,000 feet of the Brunswick formation in Pennsylvania, its exact position is also indeterminate. It further does not seem advisable to attempt extrapolation into other districts, where the succession of formations is in general quite different from that here outlined. But the absence of beds of uppermost Triassic or even of Jurassic age can in no way be regarded as certain.

It is to be concluded, then, that there is no evidence whatever of the deposition of any part of the New Red or Newark group during the Permian period; but since all of the fossils of diagnostic value, indicating middle-upper Triassic age, have come from a rather limited horizon, about the middle of the group, we are not justified in concluding either that the whole group is of the same age or that the Bunter sandstone below and the upper Keuper or Rhætic above are not represented in the American rocks.